Bay County Mosquito Control

2010 Annual Report

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Organization

Bay County Mosquito Control began operations within the organizational structure of the Bay County Health Department and under the auspices of the Bay County Executive in January of 1985. The program began in 1977 as part of the bi-county district, Saginaw-Bay Mosquito Control Commission.

Mosquito "control" doesn't mean elimination, but involves IPM (Integrated Pest Management) methods designed to reduce the number of mosquitoes so they no longer unfavorably affect the health and quality of life of Bay County residents.

As one of the divisions of the Environmental Affairs and Community Development Department, we acknowledge the importance of serving the public by providing services without producing adverse impacts on the environment. The program consists of field operations, biological surveillance, disease surveillance, and education.

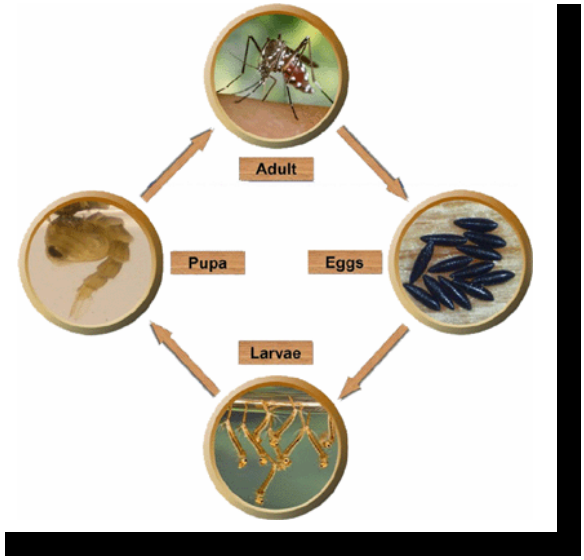
Bay County is one of four Michigan counties with formal, comprehensive mosquito control programs. A Technical Advisory Committee (TAC), composed of local and state professionals, reviews program operations each March.

Funding is received from a special millage for the control and abatement of mosquitoes and the diseases borne by mosquitoes. The current 0.45 mill tax levy was renewed on August 5, 2008 for an additional eight years in Bay County with an overwhelming approval rating of 84%. This millage rate has been in place since 1988.

Mosquito Biology and Life Cycle

Mosquitoes are aquatic insects that undergo a complete metamorphosis involving four distinct stages—egg, larva, pupa, adult—throughout their life cycles. Female mosquitoes can develop several hundred eggs with each blood meal and lay them in or around water. The eggs are laid on moist ground, on the water's surface, or attached to one another to form a raft that floats on the water's surface. Eggs laid on water hatch quickly and release larvae that wriggle through the water. The larvae are filter feeders that eat voraciously and outgrow their skin, causing several molts (shedding of the skin) before pupation. About one week after the eggs hatch, larvae change to pupae, the non-feeding stage where the final transformation to adulthood takes place. Eclosion is the emergence of the adult mosquito from the pupal case. These newly-emerged adults use the cast skin for support until their wings and body dry, at which time they fly away.

After mating, females seek out an animal upon which to feed and this blood provides protein to develop eggs. Males do not bite, but do have sucking mouthparts to obtain plant nectar as a source of energy; females do this as well. Next, females search for an aquatic habitat or moist ground to deposit eggs. Although there are exceptions to the rule, most adult mosquitoes live for a period of four to eight weeks.



Spring Larval Surveillance

As a result of spring flooding due to rainfall or snowmelt, the potential exists each year for significant spring mosquito larval development in the woodland areas of Bay County. Spring aerial treatment utilizing one helicopter and two fixed wing aircraft was conducted when larvae reached the third instar growth stage. Monitoring larval development was critical in order to have a timely application of *Bti* (*Bacillus thuringiensis israelensis*), a bacterium eaten by larvae that caused mortality within 48 hours. The *Bti* may be used as a safe food source by other aquatic organisms that occupy the same woodland pool habitats.

Surveillance was an essential part of the successful mosquito control program. Mosquito larval surveillance began in early March with first instars observed in woodland pools on March 10. Woodlots were very dry with water levels much below average and a few woodlots completely dry. Spring weather in Michigan is usually more volatile than stable and changes in weather create challenges to mosquito control. Rainfall in March totaled a mere 0.73" while April rebounded and saw 2.63". From April 3-8, 1.45" of rain fell, flooding new areas and triggering a new hatch of larvae, many of which were *Aedes vexans*, a summer species. Pools had formed in many woodlots and monitoring indicated low density (1-5 larvae per dip) in most sites. Pre-treatment larval counts were taken between one and four days before treatment in 34 woodlots; forty woodlots were monitored, but six were dry and counts could not be obtained.

Aerial calibration took place on April 10th with treatment beginning immediately and lasting seven days until April 16th. Aircraft were calibrated to deliver approximately 5 pounds of *Bti* per acre for most of the application. On April 14, however, both airplanes were recalibrated to 4 pounds per acre to treat Mt. Forest and Gibson townships.

Quality control of the spring aerial campaign was accomplished with the help of a full-time supervisor, biologist, and four certified technicians. Staff walked through 107 treated woodlots over the course of the campaign in order to determine both the average number of *Bti* granules per square foot, which helped confirm the dosage rate, and locate possible skips or misses occurring with the aerial application. The number of granules per square foot averaged 3.83 for all woodlots checked, which corresponded to 5 pounds/acre.

Quality Control Crew

Post counts indicated an overall average 97.5% larval mortality (Table 1). Most woodlots had excellent *Bti* coverage and, as usual, where there was *Bti*, there were either no mosquito larvae found or only dead larvae floating throughout the water column. Frogs, tadpoles, fairy shrimp, water fleas, copepods, and caddisflies that were observed in the woodland water habitats before treatment were found in large numbers after treatment, as well.

Table 1

Spring Treatment 2010 - Bti Evaluation				
		Larval Count		
Location	Applicator	Pre	Post	Mortality
Bangor 4 - Bangor Oil Well	Helicopter	2.68	0	100%
Bangor 31 - St. Maria Goretti Church	Helicopter	1.2	0.1	91.7%
Bangor 33 - Bangor and Zimmer	Helicopter	5.42	0.03	99.4%
Beaver 4 - 1576 Cottage Grove	Fixed Wing	1.5	0	100%
Beaver 5 - Carter and Cottage Grove	Fixed Wing	4.02	0	100%
Beaver 9 - 1585 Cottage Grove	Fixed Wing	2.32	0	100%
Frankenlust 2 - Four Mile and Delta	Helicopter	DRY		
Frankenlust 3 - Delta by Automotive Bldg.	Helicopter	DRY		
Frankenlust 7 - 259 Amelith Road	Helicopter	16.9	0	100%
Fraser 6 - Townline 16 by 7 Mile Road	Fixed Wing	1.16	0	100%
Fraser 11 - Camp Fishtales	Fixed Wing	0.65	0	100%
Fraser 15 - Fraser Twp. Firebarn	Fixed Wing	DRY		
Fraser 22 - Fraser Twp. Hall	Fixed Wing	1.98	0.16	91.9%
Garfield 9 - 11 Mile N. of Erickson	Fixed Wing	1.02	0.02	98%
Garfield 10 - Garfield Twp. Park	Fixed Wing	2.62	0.3	88.5%
Garfield 15 - Methodist Church	Fixed Wing	0.64	0	100%
Garfield 26 - Crump Fox Club	Fixed Wing	2.7	0	100%
Kawkawlin 2 - 2080 LeBourdais Road	Fixed Wing	DRY		
Kawkawlin 30 - Bay City Bowmen's	Fixed Wing	DRY		
Kawkawlin 30 - White Birch Village	Fixed Wing	1.62	0	100%
Monitor 9 - 1306 Wheeler	Helicopter	2.47	0	100%
Monitor 20 - Fraser and N. Union	Helicopter	1.92	0.14	92.7%
Monitor 23 - Rocking Horse Ranch	Helicopter	1.48	0	100%
Monitor 28 - Mackinaw Road Tech Park	Helicopter	1.6	0	100%
Monitor 34 - Fremont Cemetery	Helicopter	2.93	0	100%
Pinconning 19 - Pinconning County Park	Fixed Wing	1.2	0	100%
Pinconning 23 - KC Hall Water Street	Fixed Wing	0.8	0	100%
Williams 16 - Carter and N. Union	Fixed Wing	1.54	0	100%
Williams 19 - Victoria Woods Trailer Park	Fixed Wing	2.52	0	100%
Williams 20 - Forest School/Daycare	Fixed Wing	1.06	0	100%
Williams 21 - Forest Edge	Fixed Wing	1.5	0.2	86.7%
Williams 30 - Rockwell and Salzburg	Fixed Wing	22.9	1.16	94.9%
*Mt. Forest 9 - Sand and Eleven Mile	Fixed Wing	1.4	0	100%
*Mt. Forest 17 - Carter N. of Cody-Estey	Fixed Wing	1.8	0.02	98.9%
*Mt. Forest 20 - Flajole N. of Pinconning	Fixed Wing	2.04	0.26	87.3%
*Mt. Forest 21 - Mt. Forest School	Fixed Wing	3.44	0.26	92.4%
*Mt. Forest 21 - Mt. Forest Firebarn	Fixed Wing	DRY		
*Mt. Forest 30 - Pinconning and County Line	Fixed Wing	2.02	0.06	97%
Frankenlust 3 - Delta by Mackinaw Road	Control	2.47	2.77	0%
Mt. Forest 30 - Pinconning and County Line	Control	2.3	2.02	12.2%
AVERAGE MORTALITY (treated)				**97.5%**

* Woodlot treated at a 4 lb/acre dosage rate.

Summer Larval Surveillance

Surveillance is the key component of an IPM (Integrated Pest Management) program and there are two main types — larval and adult — both of which are done to monitor mosquitoes county-wide to determine distribution, density, and species composition. Surveillance is a combined effort conducted by larviciding crews, field supervisors, and biology personnel.

Staff conducted routine surveillance of probable mosquito breeding sites using a standard pint-size dipper. These stagnant water sites included ditches, catch basins, flooded fields, woodlots, and tires. Roadside ditch larval site inspections, termed sequential sampling, occurred weekly throughout the county and larval samples were collected and identified to determine the need for control. Two hundred twenty larval samples representing ten species were identified; the majority were *Aedes vexans* followed by *Culex restuans* and *Culex pipiens*. Thirteen larval samples were identified as *Aedes japonicus,* the newest mosquito species to Bay County, which was found breeding in tires, containers, and ornamental ponds.

To assess the activity of *Culex* mosquitoes in city and suburban catch basins, biology staff randomly inspected 40-50 basins on 4 occasions. The basins are a perfect habitat, providing *Culex* mosquitoes with standing water and decomposing leaf litter. *Culex restuans* larvae were found by June 18, which prompted the initial treatment using VectoLex CG. In order to determine efficacy and longevity of the control material, basins were inspected every three weeks. VectoLex provided excellent control through four weeks-post treatment.

Quality control continued to be an essential function for biology technicians. Habitats that were recently treated were re-checked to ensure control materials were properly applied and effective. Quality control efforts began with surveys of woodlots in April to assure proper treatment. Container, roadside ditch, and catch basin surveys continued as the summer wore on.

New Jersey Light Traps

As in previous years, Bay County Mosquito Control completed regular mosquito trapping throughout the season. Trapping data was critical to the mosquito management program as it helped recognize mosquito numbers, species, and whether or not any of the mosquitoes were a disease threat. One of the main tools used in adult surveillance was the New Jersey Light Trap. Beginning in mid-May and continuing through mid-September, adult mosquitoes were collected in 15 traps placed throughout the county. The traps were placed in backyards where there was little or no competing light source. Samples were gathered three times each week, followed by counting and species identification. The total capture was 16,485 (Table 2), nearly two times more than the 2009 season (a cooler summer) and slightly higher than the historical average of 15,012.

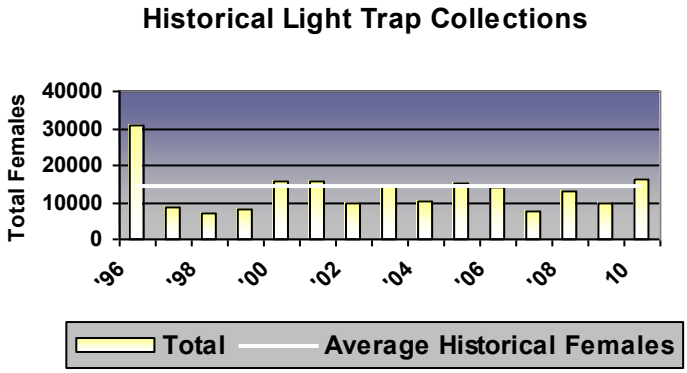
Table 2

Species	May	Jun	Jul	Aug	Sep	TOTAL
Ae. vexans	715	3536	2756	2775	131	9913
Ae. intrudens	2	6	0	1	0	9
Ae. implicatus	0	1	0	0	0	1
Ae. stim/fitchii	15	107	149	4	0	275
Ae. canadensis	0	2	0	0	0	2
Ae. triseriatus	0	0	7	5	0	12
Ae. trivittatus	0	34	30	14	0	78
Ae. sticticus	0	9	1	0	0	10
Ae. japonicus	1	5	4	8	0	18
An. punctipennis	5	21	26	59	6	117
An. quadrimaculatus	32	133	720	1630	107	2622
An. walkeri	10	72	131	322	157	692
An. perplexens	0	2	0	4	4	10
Cs. inornata	2	0	0	1	6	9
Cs. morsitans	0	0	0	0	1	1
Cq. perturbans	2	725	586	55	2	1370
Cx. pipiens	0	26	160	70	3	259
Cx. restuans	19	86	237	297	42	681
Cx. territans	0	6	2	102	46	156
Ps.ciliata	0	0	0	0	0	0
Ps.ferox	0	0	0	0	0	0
Ur. sapphirina	0	0	0	22	24	46
Damaged	3	78	90	33	0	204
Male Mosquitoes	584	2192	1574	1966	272	6588
Total Females	806	4849	4899	5402	529	16485

Twenty-one species were collected during the 2010 season and the most predominant was *Aedes vexans*, representing 60% of the total. It is not unusual for *Aedes vexans* to rank first because it's the floodwater mosquito and hatches after heavy rains flood ditches, fields, and woodlots. The *Anopheles* species (*quadrimaculatus*, *walkeri*, *punctipennis*, and *perplexens*) represented about 21% of the total catch. The cattail marsh mosquito, *Coquillettidia perturbans* ranked third. Finally, we watched, with great interest, our newest mosquito species, *Aedes japonicus,* whose numbers remained virtually unchanged from 2008 and 2009 when ten were captured in each year.

Figure 1 offers a historical perspective of light trap collections with the average number collected in a given year represented by the solid white line. As you can see, the number collected in 2010 was slightly above average. Typically, total number of females corresponds with the amount of rainfall received. During the first 10 months of 2010, Bay County received below-average precipitation. Historically, 26.85 inches have been recorded, but 2010 saw 21.65 inches. In a twelve-month period from November 2009-October 2010, 10 months saw below-average precipitation. Only May and June were above average with May receiving 14% more rain than an average year and June 78% more. These rains lead to an increased number of mosquitoes that no doubt were bothersome to Bay County citizens considering the above-average temperatures from May-October. More mosquitoes will be active and collected on warm evenings like those experienced this season. Average mean temperatures during the seasonal trapping time frame were 61.6˚F (May), 68.5˚F (June), 75.3˚F (July), 73.7˚F (August), and 61.6˚F (September). Figure 2 (page 13) shows mosquito species collected per trap night throughout the summer. Summer floodwater *Aedes* peaked the week of June 14th and again on August 16. These peaks followed major rain events by 1-2 weeks.

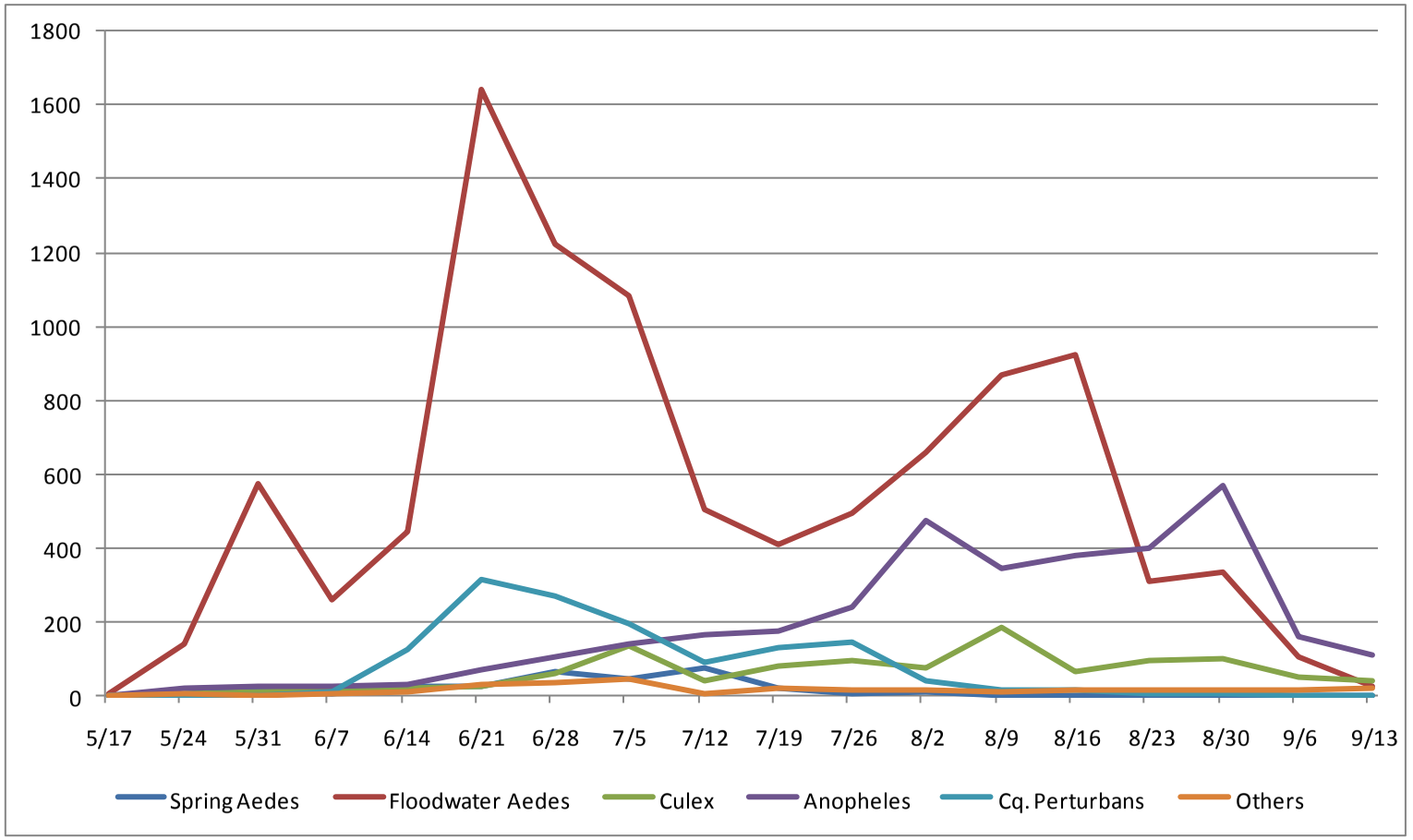
Figure 1



New Jersey Light Traps 2010

Weekly Captures

Figure 2



CDC Traps

CDC Traps attract blood-seeking female mosquitoes with the use of dry ice (carbon dioxide) as bait. Traps were placed overnight within woodlots, summer festival grounds, treatment sites, and personal residences. Usually the traps held diverse species and larger mosquito numbers compared to New Jersey Light Traps. Traps were also used to assess homeowner complaints, gather arbovirus information, and record changes in abundance of mosquitoes before and after control operations.

Total number of mosquitoes captured in CDC traps this year was 25,504 (Table 3). *Aedes vexans* (and other summer floodwater *Aedes*) remained at the top ranking spot, representing 72% of the total with *Coquillettidia perturbans* numbers down from 2009, comprising 12% of this year's total. Twenty-two species in six genera were collected and identified, averaging 102 females per trap, up slightly compared to 97 in 2009. The average number of females in 2008 and 2007 was 175 and 118, respectively.

Table 3

Species	May	Jun	Jul	Aug	Sep	TOTAL
Ae. vexans	1300	6015	2451	3162	254	13182
Ae. cinereus	1	2	0	0	0	3
Ae. intrudens	33	23	0	1	1	58
Ae. implicatus	17	42	0	0	0	59
Ae. sticticus	0	270	1	0	0	271
Ae. stim/fitchii	219	261	123	22	0	625
Ae. canadensis	265	25	0	1	0	291
Ae. provocans	11	0	0	0	0	11
Ae. triseriatus	0	26	16	10	0	52
Ae. trivittatus	178	2771	1474	662	11	5096
Ae. japonicus	0	0	0	3	0	3
An. punctipennis	4	14	5	9	2	34
An. quadrimaculatus	7	84	136	829	0	1056
An. walkeri	0	421	3	42	2	468
An. perplexens	0	0	0	0	0	0
Cs. inornata	0	1	0	0	0	1
Cq. perturbans	0	1752	1118	152	0	3022
Cx. pipiens	0	19	67	52	3	141
Cx. restuans	10	58	461	288	2	819
Cx. territans	1	0	0	7	1	9
Ps. ferox	0	2	0	24	0	26
Damaged	16	158	72	30	1	277
Total Females	2062	11944	5927	5294	277	25504

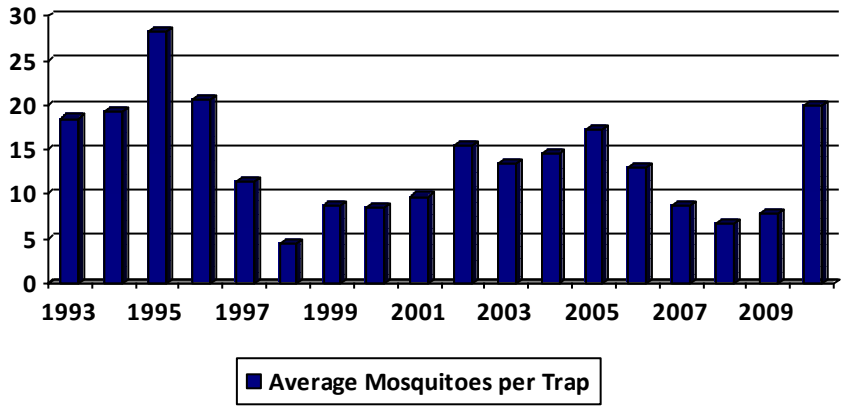
Gravid Traps

Gravid traps offered another method to collect female mosquitoes, primarily *Culex* species that had taken a blood meal and were searching for a suitable place to lay eggs (oviposit). This trap was selective for female mosquitoes that had at least one blood meal; therefore, the traps provided a good means for early West Nile Virus (WNV) detection.

A solution containing water, brewer's yeast, whey, and guinea pig pellets was allowed to ferment for about a week before being poured into a plastic tub, over top of which sat the gravid trap. This organically-rich water was the attractant to gravid (egg-bearing) females.

Gravid trap placement ran from June through September and 142 traps captured 3096 mosquitoes (2836 *Culex* species, 13 *Ae. japonicus*, 16 *Ae. vexans*, 29 *Anopheles* species, 1 *Ae. trivittatus*, 4 *Cq. perturbans*, 1 *Ae. stimulans/fitchii*, 20 damaged females and 176 males). Traps were placed in a variety of locations, including the immediate area of WNV activity. *Culex* mosquitoes collected in gravid traps were grouped together and submitted to MSU for WNV-detection or tested in-house with the VecTest kit. Figure 3 shows a historical perspective of the average number of mosquitoes collected per gravid trap.

Figure 3



Disease Surveillance

Since the inception of Bay County Mosquito Control, efforts have been targeted at controlling known disease vectors as well as nuisance mosquito species. While reducing annoyance and improving quality of life are important, the primary goal of our program has always been to reduce mosquito numbers in order to decrease the risk of diseases transmitted by them. Since WNV came on the scene in 2001, our efforts at disease prevention and public education have taken on a bigger role.

St. Louis encephalitis, eastern equine encephalitis, LaCrosse encephalitis, West Nile virus, and dog heartworm are all mosquito-borne pathogens found in Michigan. Mosquito pools were submitted to MSU's Microbiology and Molecular Genetics Department to be analyzed for these disease agents. A mosquito pool is a group of up to 25 mosquitoes of the same species collected from a trap, placed in a vial, and tested for mosquito-borne disease. Some mosquito pools were also tested in-house using the VecTest kit. Four hundred eighty pools containing 8,054 females representing a variety of species were tested with the following results: *Cq. perturbans* (212 pools/3,800 females/no positives), *Culex* restuans/pipiens (267 pools/4,251 females/no positives), and *Aedes japonicus* (1 pool/3 females/no positives). A positive pool indicates local mosquitoes are infected with West Nile Virus and are capable of transmitting it to humans and other hosts.

We continued to rely on Bay County citizens reporting dead birds as one method of WNV surveillance. Using the WNV VecTest kit, American Crows and Blue Jays were tested to determine infection rates. The number of calls was down significantly this year from 100 in 2008 and 27 in 2009 to 17 this year. Twenty-five dead birds were reported, most of which were Robins (9), Common Grackles/European Starlings/ other blackbirds (8), Blue Jays (4) and American Crows (2). All dead bird sightings were logged onto Michigan's Emerging Diseases website www.michigan.gov/emergingdiseases. Four crows or jays were tested with none testing positive. Compared to 2008 and 2009, disease activity remained at a low level for our county, but statewide, disease activity increased. There were 29 human cases reported this summer (Table 4) with 3 fatalities occurring in Macomb County and 3 crows tested positive in Midland County. Furthermore, 7,419 mosquito pools containing 57,191 females were tested for either West Nile, St. Louis, Lacrosse, or Eastern Equine encephalitis and of those only 1 pool from Ingham County tested positive for West Nile encephalitis.

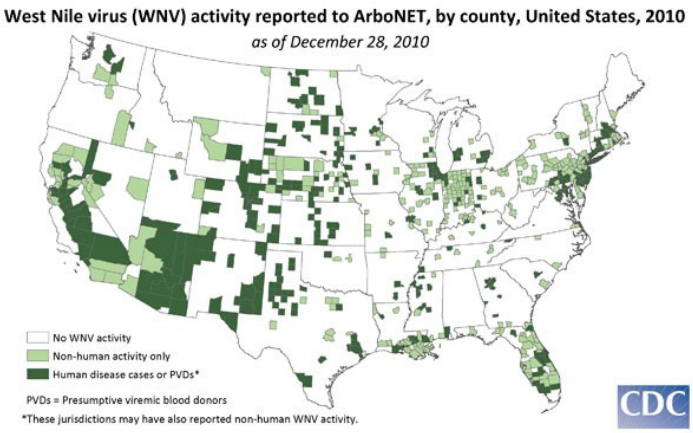
An outbreak of Eastern Equine Encephalitis (EEE) in horses occurred primarily in the southwest portion of Michigan (Calhoun, Barry, Kalamazoo, and Cass Counties) with 55 lab-confirmed equine cases and 77 additional suspect cases. The EEE activity prompted the Michigan Department of Community Health to issue press releases advising the public to take precautionary measures when EEE was identified in horses or people in their area. Nationally, there were 981 human WNV cases (a 60% increase over 2009) with 45 deaths. Most of the U.S. cases (Figure 4) occurred in Arizona (163 with 13 deaths), New York (127 cases with 3 deaths), and California (104 cases with 2 deaths).

Table 4

Michigan Human WNV (Statewide)

Year	Total Cases	Fatalities
2010	29	3
2009	0	0
2008	17	0
2007	13	2
2006	55	7
2005	62	4
2004	16	0
2003	19	2
2002	614	51

Figure 4



Product Evaluations

A new bacterial product known as Natular™, with active ingredient *Saccharopolyspora spinosa* (a.k.a. spinosad), was evaluated for the second consecutive year in catch basins over an eight-week period. During the same time period, a second product called FourStar™ 90-day briquets was applied to a four-block area in Essexville. With the exception of the catch basins treated with FourStar and a four-block area left as a control, all other catch basins in the city of Essexville were treated with the Natular XRT (Extended Release Tablet) 180-day formulation.

Twenty-two catch basins were monitored—eighteen that received treatment and four that were left as untreated controls. Pre-treatment surveys were taken followed by treatment on July 19. Post-treatment surveys were then taken weekly thereafter through September 15. Catch basin lids were lifted and 4-5 dips per catch basin were taken with water deposited in an enamel pan. Close inspection of any mosquitoes in the pan was completed and results recorded. A total mosquito count was taken and then averaged.

Throughout most of the summer, *Culex restuans* were the primary mosquito found in catch basins, but by September, most larvae were *Culex pipiens* species. Excellent control was achieved throughout the study with Natular (99.4% mortality). Only one of the monitored treatment catch basins saw fourth instar larval or pupal activity during the study. The other catch basins primarily saw no larval activity or early stage larval activity only. The presence of third instar larvae or larger may indicate the product is no longer working. Mosquitoes in untreated control catch basins were found in all larval stages as well as pupae, with more adults flying from the basins as time went on. Natular has shown promise as a residual mosquito control material.

The microbial larvicide FourStar, which contains *Bacillus sphaericus* (*Bsph*) and *Bacillus thuringiensis israelensis* (*Bti*) also showed promise. After an initial average larval count of 30+ per basin, larval numbers throughout the study dropped significantly, rebounding to an average of 3.5 per dip with no pupae found in the treated catch basins. When the product is working effectively, it is ingested by first through third instar larvae, causing their mortality. Theoretically, larger instars and pupae should not be seen if the product is still viable.

A small-scale trial of liquid Natular 2EC in roadside ditches showed that at a dosage rate of 2 fluid ounces per acre, Natular controlled 100% of 1st-3rd instar larvae when a 24-hour post count was taken. No mortality was seen in the untreated control ditches.

Weather

Mosquitoes, whose lifespan usually doesn't exceed more than three weeks, breed in stagnant bodies of water. Heavy rainfall can leave puddles and other bodies of water in which mosquitoes multiply. In both March and April the trend was warmer than average temperatures and below-average precipitation. In March little rainfall was recorded, leading to small woodland pools drying completely. Only the months of May and June saw above-average rainfall with May recording 3.45" and June 4.49", an inch and a half above normal. Rain fell daily in the first 9 days of June with 2.2" recorded. This led to our highest spike of *Aedes vexans* (>1,600 females in light traps). July rainfall in the mid-Michigan area showed a large variance, with Bay County receiving 2.09" while 6-8" were recorded in some areas in neighboring counties. September and October remained dry.

The 2010 season can be summed up as warm and dry. Beginning in January and continuing on through the spring, summer, and fall, above-average temperatures remained intact.

It is imperative to maintain weather data to predict both larval occurrence and when biting adults will emerge. Table 5 lists weather data occurring in Bay County during November-December of 2009 and January through October, 2010.

Table 5

Month	Normal Rainfall	2009/2010 Rainfall	Departure from Normal	Normal Average Mean Temp.	2009/2010 Average Mean Temp.	Departure from Normal
November	2.65"	0.55"	- 2.1"	38°	43.2°	+5.2°
December	2.11"	1.47"	-0.64"	27°	26.9°	- 0.1°
January	1.77"	1.01"	- 0.76"	21.4°	22.5°	+1.1°
February	1.57"	1.21"	-0.36"	23.8°	27.3°	+3.5°
March	2.42"	0.72"	-1.7"	33.5°	39.2°	+5.7°
April	2.82"	2.16"	-0.66"	45.5°	51.9°	+6.4°
May	2.89"	3.45"	+0.56"	57.6°	61.6°	+4.0°
June	3.06"	4.49"	+1.43"	66.8°	68.5°	+1.7°
July	2.5"	2.09"	- 0.41"	71.2°	75.3°	+4.1°
August	3.38"	2.63"	-0.75"	68.7°	73.7°	+5.0°
September	3.95"	2.38"	-1.57"	60.7°	61.6°	+0.9°
October	2.49"	1.46"	-1.03"	49.5°	51.0°	+1.5°

Spring Aerial Campaign

The 2010 mosquito control season began in April with aerial larviciding to control spring woodland mosquitoes. The operation targeted vulnerable larvae before they reached the adult, biting stage. The aerial program has gone on for over three decades in the Saginaw Valley and remains the best way to dramatically decrease numbers of spring *Aedes* mosquitoes. The preferred control method has been using a bacterial product known as *Bti* (*Bacillus thuringiensis israelensis*).

Earl's Spray Service, Inc. of Wheeler, Michigan used two aircraft to apply *Bti* to 33,750 woodland acres in the following townships: Beaver (5,576 acres), Fraser (4,957 acres), Garfield (4,957 acres), Gibson (1,144 acres), Kawkawlin (1,549 acres), Mt. Forest (5,034 acres), Pinconning (7,745 acres), and Williams (2,788 acres). Calibration, loading, and fueling of the aircraft took place at Barstow Airport in Midland and sites were treated with VectoBac® *Bti* corncob granules at 4-5 pounds per acre.

Clarke Mosquito Control of Roselle, Illinois utilized one Jet Ranger helicopter to apply *Bti* to 7,680 acres the following townships: Bangor (2,464 acres), Frankenlust (816 acres), Hampton (280 acres), Mt. Forest (2,472 acres), Merritt (192 acres), Monitor (1,304 acres), and Bay City EastPortsmouth (152 acres). Calibration took place at Barstow Airport with a variety of loading and fueling sites utilized to decrease ferry time.

Spring Ground Surveillance/Larviciding

Four certified technicians helped with aerial quality control, conducting post-treatment surveys to assess *Bti* application. Following the completion of the aerial treatment program, these same technicians were the first to begin inspections and subsequent ground treatment using primarily *Bti* and BVA2 larvicide oil to manage the larvae or pupae. The first pupae were recorded on April 15. Field technicians began to treat woodland pools with larvicide oils, concentrating on smaller woodlots not feasibly treated by aircraft.

Table 6 lists the number of acres treated by foot crews and material used in smaller tracts of woodlots during the 2010 spring season. Almost 135 acres received larval treatment by ground crews to control the emergence of the pestiferous spring *Aedes* mosquito. The crews checked 184 sites, dipping each one, to determine the need for treatment. A total of 63 sites were treated; about 30% were dry. A total of 82.3 gallons of BVA-2 larvicide oil were dispensed at a dosage rate of 1 gallon/acre. Later, when early May rains brought on another hatch in the woodlots, technicians re-treated a few woodlots near major population centers with *Bti*, dispensing about 260 pounds and treating 52 acres. Significant emergence of spring *Aedes* adults occurred on or about May 3, with the second hatch of *Aedes vexans* adults occurring a week later. This initiated adulticiding or the control of adult mosquitoes through fogging operations.

Table 6

Spring Ground Treatment

Township	Acres Treated	BVA2 (gal)	Bti (lb)
Bay City West	6.3	6.3	
Bangor	42.2	7.4	173.9
Frankenlust	3.7	3.7	
Fraser	6.3	6.3	
Kawkawlin	4.2	4.2	
Hampton	23.7	23.7	
Monitor	26.9	9.7	85.8
Mt. Forest	0.4	0.4	
Pinconning	12.7	12.7	
Portsmouth	1.5	1.5	
Williams	6.4	6.4	
Total	**134.3**	**82.3**	**259.7**

Summer Larviciding

Bay County residents enjoy spending time outdoors during summertime, but the presence of mosquitoes can interfere with outdoor recreation. We try hard, therefore, to reduce mosquito numbers so residents can enjoy Michigan's all-too-short summer.

Our comprehensive mosquito control program focused on routine surveillance and control of potential breeding sites to prevent adults from emerging. This program involved MDA-certified technicians applying insecticides to stagnant water throughout the county. During the breeding season, a team of 21 technicians inspected water habitats guided by a database of known breeding sites, citizen complaints, and high trap numbers. Homeowners were notified of property inspections either in person or through the use of a door hanger.

Efforts directed at larval control were accomplished by using bacterial, chemical, or sanitary (dumping water from containers) methods. Four microbial products utilized to control larvae were VectoBac®G (*Bti*), *Bti* Briquets™, VectoLex® CG (*Bacillus sphaericus*) and Natular XRT *Saccharopolyspora spinosa*); chemical insecticides included materials containing temephos (1% Skeeter Abate®, Provect 1G, ProVect 4E and Abate® 4-E), alcohol-based monomolecular surface films (Agnique® MMF) and petroleum-based oils (Golden Bear—1111 and BVA2). The Agnique MMF was used near the Lake Huron bay front as well as sensitive wetland areas.

Larval Sites: The total number of breeding sites changes each year as new sites are added to the database and others are deleted. A total of 18,570 larval site inspections were conducted this season, but only 16% of those were actually treated with a larvicide material. These numbers are in keeping with previous years' data. Some of these sites were permanent breeding habitats while others were temporary and included ditches, containers, fields, woodlots, tires, idle pools, ornamental pools, and Saginaw Bay beachfront. Larvae were sampled by quickly skimming the water's surface with a dipper; some were collected and returned to the lab for identification. Technicians also controlled mosquitoes by dumping water from buckets, pails and other man-made containers (one method of source reduction) on a regular basis. This was the preferred method to eliminate mosquitoes from breeding in containers.

Events: In addition to surveillance and control in neighborhoods throughout the county, special attention was given to summertime outdoor recreational events, such as the Auburn Cornfest, Munger Potato Festival, Pig Gig Ribfest, and River of Time, to name a few. According to the Bay Area Convention and Visitors Bureau, over a half million people attend these types of festivals. Controlling larvae prevents adults from emerging and interfering with outdoor recreation and activities.

Ditch Treatments: Bay County's topography is very flat and most roadways are flanked by ditches, which divert water from the county's 1,400 miles of roads. In addition, ditches serve as breeding grounds for mosquitoes, so a lot of attention is given to monitoring mosquito activity within them. In fact, surveys are made by lab personnel once each week. Most problems with breeding occur after major rainfall events, which stimulate mosquito eggs to hatch. Ditch trucks logged 7,425.9 miles driven, dispensing 1,249 gallons of Abate 4E mix (4.9 gal of Abate 4E), 2,977.04 gal of AquaBacXT mix (248 gal Bti), and 12.2 gal of BVA2.

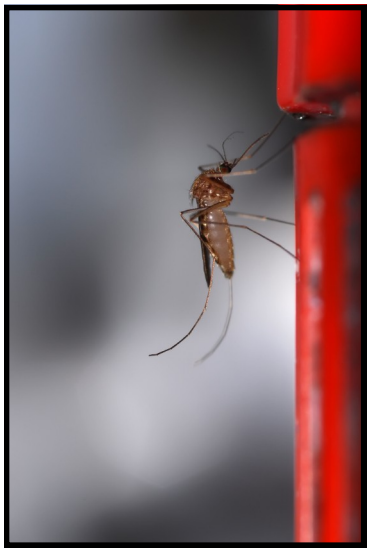
Catch Basins: BCMC staff monitored mosquito breeding in catch basins and used 786.9 lb of VectoLex® CG bacterial larvicide to treat 27,987 catch basins, 12,694 fewer than 2009. The reduction stemmed from a delay in obtaining a MDEQ permit, which meant that the first treatment that would have normally taken place in early June didn't occur until July. In addition, 405 Natular XR 180-Day Tablets were used to treat Essexville catch basins as were 32 Four-Star briquets. Two-thirds of a gallon of BVA2 was also dispensed into catch basins.

Sewage Lagoons: Sewage lagoons are perfect breeding zones for *Culex* mosquitoes as they're filled with polluted, highly organic water all summer long. One sewage lagoon was monitored this season resulting in 5 treatments using the following products: 9 *Bti* Briquets, 19 gal of BVA2, and 42.82 lb of Bti G. No temephos was dispensed in sewage lagoons this year, as the MDEQ limited its use.

Retention Ponds: These ponds were designed to hold storm water until the water either percolated or evaporated, which returned the area to its normal dry state. Floodwater mosquitoes were usually the first to appear in retention ponds, but *Culex* and *Anopheles* mosquitoes could also be found. BCMC surveyed 106 retention ponds throughout the county, treating them with a variety of products: Provect 1% (16.2 lb), *Bti* Briquets (87.5), *Bti* (351.5 lb), BVA2 (41.49 gal), AquaBac XT mix (2 gal), and Agnique MMF (0.3 oz). As in other larviciding endeavors, treatment did not occur after each survey. In fact, 642 larval surveys of retention ponds were made with nearly 71% of these resulting in no treatment.

Retention Pond books were used during the 2010 season for the second time. The books contained detailed information about the location and size of each retention pond and were organized by township. Each retention pond was shown on an aerial map to give technicians a way to quickly locate them. The idea behind the retention pond books was to make surveillance and treatment more efficient and timely.

Adulticiding



While larval control was the preferred method of treatment, it was virtually impossible to find and treat all breeding sites, so adulticiding (fogging to kill adult mosquitoes in flight) was also carried out to control mosquitoes. Adult mosquito activity increased following periods of heavy rains, which caused new mosquito broods to hatch. Fogging adult mosquitoes included the use of ULV (Ultra Low Volume) equipment that allowed a relatively small amount of material to be dispensed. Application rates were adhered to by using GPS units with SmartFlow technology in each truck. Label recommendations were followed strictly to assure proper dosage rates and droplet sizes during adulticide applications. To accomplish the latter, droplet measurements were taken several times throughout the season. The first droplet characterization session took place in early May with Jake Britton (sales representative from Clarke) using the AIMS (Army Insecticide Measuring System) to measure aerosol droplets (see picture at right); software was utilized to store electronic files. Subsequent checks of droplet sizes took place using the Teflon® slide method.

When weather conditions were conducive to fogging (temperatures above 50°F and winds below 10 mph), eight certified technicians fogged cities and townships that had either the highest mosquito counts or noted disease activity. This year saw the routine use of the permethrin product Kontrol® 4-4. Mosquitoes must come in contact with the droplets in order for the insecticide to be effective so adulticiding activities took place after sunset when most mosquito species were active and bees had returned to their hives.

For management purposes, Bay County initiated the use of route maps during adulticiding operations. These road maps of each township showed the most efficient route to follow when adulticiding. The maps also highlighted addresses of medical and no spray residences. Medical residences are homes that qualify to be a part of our Medical Needs Program because at least one resident is allergic to mosquito bites or has verifiable medical needs. The medical condition must be confirmed by a medical doctor. No spray residences are homes that prefer not to be treated for mosquitoes.

Adulticiding Treatment

Table 7

Township	Miles Treated	Kontrol 4-4 (gal)
BANG	2261.1	290.2
BCE	541	130.1
BCW	431	110.1
BEAV	812.1	170.6
ESSE	140.9	32.8
FRAN	712.9	139.5
FRAS	873.3	175.1
GARF	840.4	198.6
GIBS	568.5	114.7
HAMP	1279.1	280.8
KAWK	1607.2	388.9
MERR	762.8	156.7
MONI	2666.8	579.7
MTFO	763.5	153.4
PINC	976.5	193.6
PORT	779.8	174.3
WILL	1464.5	288.1
TOTAL	**17481.4**	**3577.2**

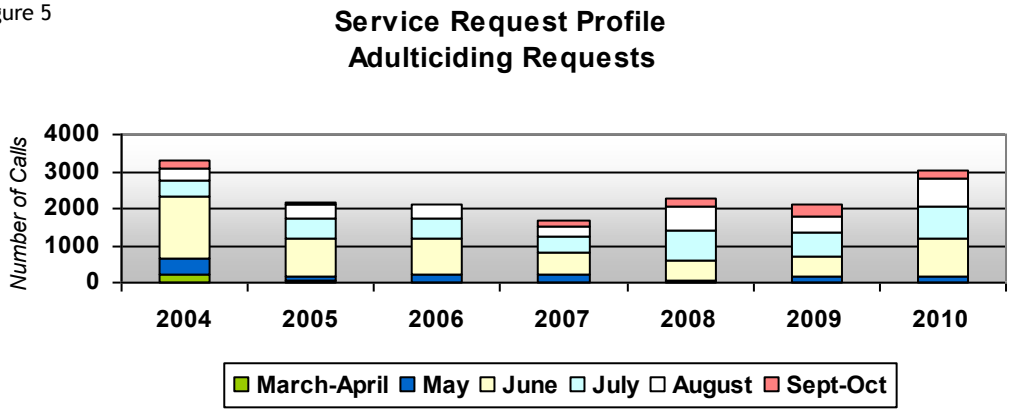
During the 2010 season, the "Long Driveway Program" continued. This program was designed to fog inhabited properties that sat a considerable distance off the main road and that did not receive adequate adult mosquito control during normal fogging operations. Sixty-two such addresses were placed on route maps to be fogged on a regular basis.

Over 17,000 miles were logged during adulticiding operations (Table 7) and nearly 3,600 gallons of Kontrol 4-4 were dispensed.

Customer Calls

Traps were the primary indicator of mosquito activity, but customer calls were also used as a means to indicate where adult populations were problematic. Office staff answered and technicians responded to 3,013 adult mosquito service requests received from Bay County citizens. Most (2,169) of the calls were regular service requests for adulticide treatment due to nuisance mosquitoes, but an additional 844 calls represented special event spray requests. Three percent of the callers also reported standing water with potential mosquito breeding; this amounted to 88 larval mosquito requests. In comparison to 2009, the level of customer service requests increased by 44%. Most of the calls were received in June (1,019), followed by July with 884; calls peaked about two weeks after major rain events. Regardless of the type of service request, all were responded to in a professional, courteous, and prompt fashion. Figure 5 represents a historical profile of adulticide requests; the number of calls positively correlates with rainfall.

Figure 5



Scrap Tire Drives

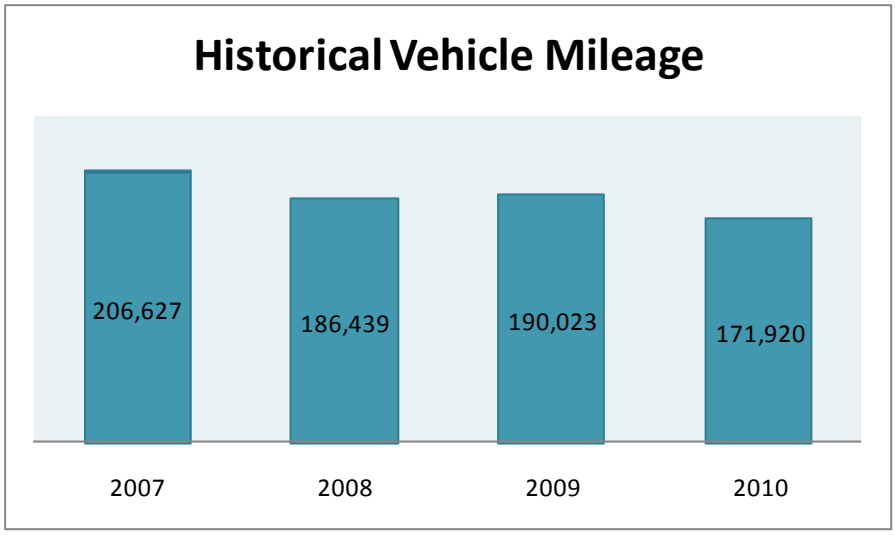
Scrap tire drives were one method of source reduction, the removal or elimination of breeding sources that currently are or have the potential to breed mosquitoes. Two community tire drives were held this summer (May 15 and October 2) with 3,644 tires collected—28% less than was collected in 2009.

Vehicle Maintenance

Bay County Mosquito Control's state-certified mechanic maintained the 32-vehicle fleet as well as four Bay County Animal Control vehicles, which were billed for parts and labor. During the 2010 season, as Figure 6 shows, 171,920 miles were driven, which is near the average of 192,251 miles.

Vehicle maintenance repairs included the following: brake systems (27), fuel systems (16), front end repairs (12), truck oil changes (69), electrical systems (42), drive lines (6), new tires (24), and used tire repair (27). In addition to maintaining the vehicles, the mechanic was responsible for repairing and maintaining equipment used by mosquito control staff. Equipment repairs included 52 ULV oil changes, ULV repairs (43), ditch truck repairs (32), Hudson® pressure sprayer repairs (4), spreader repairs (14), CDC Trap repairs (10), and New Jersey Light Trap repairs (6).

Figure 6



Education

Efforts were made to inform and educate Bay County residents about mosquito control methods and mosquito-borne diseases. A great deal of education took place every day through hundreds of personal contacts in the field and calls to the office. Periodic interviews by newspaper, television, and radio allowed discussion of news affecting the public, such as spring aerial treatment, summer programs, homeowner property inspections for water elimination, West Nile encephalitis, and scrap tire drives. Staff training was also held on a regular basis to update staff on various topics including safety, disease activity, and policies and procedures.

Presentations were also given to various groups, including school-based programs, and the Website (www.baycounty-mi.gov/MosquitoControl) was updated on a regular basis. Public relations brochures and handouts were developed and distributed at locations such as the Delta College Earth Day event (shown at left).

Membership/Certification

Memberships in professional organizations remained vital in accessing updated and new information and maintaining good working relationships with peers. Membership with the non-profit Michigan Mosquito Control Association (MMCA), American Mosquito Control Association (AMCA), and The Entomological Society of America were maintained. All were beneficial due to conferences, publications, networking, and legislative advocacy.

All staff members maintained certification with the Michigan Department of Agriculture in both the Core category and 7F (Mosquito Control). Two training sessions were held in May and June with thirty-three new and returning technicians in attendance. Staff also attended the MMCA annual meeting in Traverse City, Michigan in February and the MMCA 2010 Mosquito Control Training Session in October in Bay City, both of which offered continuing education credits.

BCMC's program plan was reviewed and approved in January by the Department of Agriculture as part of our Comprehensive Community Outreach as mandated in Regulation 637.

Staff attended the Technical Advisory Committee (TAC) annual meeting in March 2010 where the 2009 annual report and 2010 program plan were presented for review and approval.

2010 Insecticide Use Summary			
Trade Name	**Application Rate**	**Active Ingredient Dosage**	**Amount Used**
Temephos 1%	10 lbs/acre	0.1 lb temephos/acre	552.02 lb
Abate® 4E concentrate	1.5 fl oz/acre	0.0468 lb temephos/acre	4.899 gal
Bactimos Bti Briquets™	1/100 square feet	7000 AA (Aedes aegypti) Bti ITU/mg	1061.5 briquets
VectoBac® G	5 lbs/acre	0.4555 billion Bti ITU/acre	201,500 lb
Bti Liquid	1 pint/acre	0.605 billion ITU/acre	195.46 gal
Four Star™ 90-Day Briquets	1/100 square feet	60 Bacillus sphaericus ITU/mg 70 Bacillus thuringiensis israelensis ITU/mg	30 briquets
Agnique® MMF	0.2—1.0 gal/acre	0.2—1.0 gal alcohol-based surface film/acre	3.74 gal
Agnique® MMF-G	7-21.5 lbs/acre	2.24—6.88 lb alcohol-based surface film/acre	0
BVA2 Mosquito Larvicide Oil	1—5 gal/acre	0.987-2.96 gal petroleum distillates/acre	220 gal
Mosquito Larvicide GB-1111	1—5 gal/acre	0.987-2.96 gal petroleum distillates/acre	3 gal
Masterline® Kontrol 4-4	0.676 fl oz/acre	0.00176 lb permethrin/acre 0.00176 lb PBO/acre	3236.5 gal
Natular™ XRT	1 XRT tablet/catch basin	6.25% spinosad/tablet	495 tablets
Natular™ XRG	5 lbs/acre	0.125 lb spinosad/acre	0.02 lb
Natular™ 2EC	1.1-2.8 fl oz/acre	0.017-0.044 lb spinosad/acre	0.05 gal

Map of Bay County, Michigan